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James R. Brown
*Iowa State University*, jrbrown@iastate.edu

Gustav Martinsson
*Royal Institute of Technology*

Bruce C. Petersen
*Washington University in St. Louis*

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**Keywords**
Finance and growth, Innovation, Technological progress, Stock market development, Financial system architecture

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# Stock Markets, Credit Markets, and Technology-Led Growth

James R. Brown, Gustav Martinsson, and Bruce C. Petersen*

June 8, 2016

**Abstract**

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*JEL classification*: G10; O16; O40

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* Brown is at Iowa State University, College of Business, Department of Finance, 3331 Gerdin Business Building, Ames, IA 50011-1350, email: jrbrown@iastate.edu, phone: +15152944668.
Martinsson is at Royal Institute of Technology (KTH) and Swedish House of Finance (SHoF), Lindstedtsvägen 30, SE-100 44, Stockholm, Sweden, email: gustav.martinsson@indek.kth.se, phone: +46(0)87906962.
Petersen is at Washington University in St. Louis, Department of Economics, Campus Box 1208, One Brookings Dr., St. Louis, MO 63130-4899, email: petersen@wustl.edu, phone: +13149365643.

## I. Introduction

A strong case can be made that the high-tech sector is the single most important driver of long-run economic growth in advanced economies. The main reason is that the high-tech sector accounts for the vast majority of corporate R&D investment.[1] For example, in the last fifteen years, four two-digit SIC high-tech industries account for nearly eighty percent of U.S. corporate R&D. During the same period, the high-tech sector's share of worldwide patents registered at the United States Patent and Trademark Office (USPTO) is over 60%.[2]

Another distinguishing characteristic of the high-tech sector is that there is arguably no other sector more prone to underinvestment due to financing frictions (e.g., Hall, 2002). Briefly, these frictions include: i) large asymmetric information problems arising from the difficulties educating potential investors when projects involve cutting-edge science, ii) limited collateral value stemming from the intangible nature of high-tech R&D, and iii) pronounced costs of financial distress given the large fraction of high-tech market values accounted for by future growth options (e.g., Brealey and Myers, 2000). These frictions imply that both the extent and the nature of a country's financial market development can influence the performance of its high-tech sector and rate of technological progress.

In this study, we explore the role equity and credit markets play in the process of technology-led growth. Equity financing arguably has several advantages over debt (e.g., Brown, Fazzari, and Petersen, 2009) when it comes to funding high-tech investment, including: i) the nature of the equity contract is better suited for funding investments with a high chance of failure but some chance of spectacular success, ii) collateral is not pledged to secure external equity finance, and iii) equity finance does not accentuate problems of financial distress. The relative importance of stock markets and credit markets for promoting growth in high-tech remains, however, an open question, particularly given that a number of recent studies report that access to debt finance promotes innovation, particularly patenting.

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[1] See Romer (1990) and Aghion and Howitt (1992) for seminal theoretical studies on the role of R&D and innovation for economic growth.

[2] We plot these developments in Figures 1 and 3. The high-tech industries correspond to two-digit SICs 28, 35, 36, and 38. Also see the evidence on high-tech's share of patenting and patent citations in Hall, Jaffe, and Trajtenberg (2005).

Our analysis is based on a sample of 38 countries over the period 1980-2005. We begin by documenting the broad, cross-country connections between financial development, the size of the high-tech sector, and economic growth. First, we document a positive and economically significant relation between the initial share of economic activity located in high-tech industries and subsequent rates of GDP and total factor productivity growth. Next, we find a strong positive connection between a country's equity market development and the size of its high-tech sector, but no relation between credit market development and high-tech production. While only suggestive, these broad connections are consistent with the idea that equity markets are particularly important for technology-led growth.

Our main tests use data on industry-level growth rates and a difference-in-differences approach that is similar in spirit to the tests developed in a seminal study by Rajan and Zingales (RZ, 1998). RZ show that financial development has a positive differential effect on the growth of industries that are more technologically dependent on external finance. By construction, the RZ measure of industry financial dependence captures the amount of *fixed capital* investment that is not financed out of internal operating cash flow. In addition to the RZ measure of financial dependence, we also study a measure of industry R&D dependence. The addition of R&D dependence allows us to test whether the nature of financial development has a different impact on industry growth depending on the innovative-intensity of the industry.

When we include only the RZ measure of financial dependence, we find positive and significant differential effects on growth for both stock market and credit market development, similar to RZ. However, once we include *both* the RZ measure of financial dependence and industry R&D dependence, stock markets are associated with faster growth in industries with higher R&D dependence, while credit markets only have significant effects on growth in industries with high RZ dependence. That is, stock market development matters for the differential growth of high-tech industries, while credit markets have a positive differential effect on growth rates in industries that rely extensively on external finance to fund their fixed capital investments. These results are consistent with the view that stock markets are well-suited for funding risky, intangible activites, while credit finance is more important for activities with substantial collateral value.

We provide a number of tests of robustness and extensions of our main difference-in-differences findings. Notably, we reach identical conclusions if we explore the differential impact of equity markets across industries sorted by patenting activity rather than R&D intensity. We also show that the impact of stock market development on high-tech growth comes principally from higher productivity growth, not fixed capital accumulation. In addition, when we decompose growth into the number of establishments (extensive margin) and the average size of existing establishments (intensive margin), stock market development matters primarily for growth in the number of high-tech firms.

Our study is relevant for several unsettled issues in the influential literature on finance and growth (e.g., King and Levine, 1993; Levine, 1999; Levine, Loayza, and Beck, 2000; Levine, 2005). First, compared to the large literature on the distinctive role that banks play in the allocation of capital and process of economic growth (e.g., Diamond, 1984; Boot and Thakor, 1997; Stulz, 2000), only a few studies emphasize the uniqueness of stock markets (e.g., Allen and Gale, 1999; Rajan, 2012). In addition, empirical evidence on the particular importance of equity market development for economic performance is relatively limited. Zingales (2015), for example, notes that "there is remarkably little evidence that the existence or the size of an equity market matters for growth."[3] Our work highlights the comparative advantage of equity markets in financing technology-led growth.

A second outstanding issue concerns the limited evidence that the structure of financial market development matters for economic growth. Levine (2005) concludes from his survey of the finance and growth literature that "countries with better functioning banks and markets grow faster, but the degree to which a country is bank-based or market-based does not matter much". Our findings are not necessarily at odds with this conclusion, but our results do highlight different mechanisms through which stock markets and credit markets are growth-enhancing: equity markets support technology-led growth, while credit markets matter for the growth of industries that rely on external finance to fund fixed investment. Moreover, though we focus separately on stock market and credit market development, rather than financial structure *per se*, an important implication of our study is that countries with market-based financial systems should be better positioned than their bank-based

[3] A few important studies do explore the connection between stock markets and growth using aggregate data, including Levine and Zervos (1998), Rousseau and Wachtel (2000), and Beck and Levine (2004).

counterparts to finance technology-driven growth. Given the increasing importance of technological progress for growth in modern economies, our findings suggest that financial system architecture may be a more important determinant of growth going forward than research has found in the past.[4] In this sense, our findings are useful for understanding why stock markets appear to be more important for growth as an economy's level of financial and economic development increases (e.g., Tadese, 2002; Demirgüç-Kunt, Feyen and Levine, 2013).

Our study builds on and contributes to the literature in two other ways. First, our study is relevant for theoretical and empirical efforts to understand the causal connections between innovative activity, productivity gains, and long-run economic growth (e.g., Romer, 1990; Aghion and Howitt, 1992 and 1998; Bayoumi, Coe, and Helpman, 1999; Griffith, Redding, and Van Reenen, 2004). Our findings support the link between innovation and growth emphasized in these literatures, but we also highlight the key role that equity markets play in this process.[5]

Second, our study contributes to an emerging debate on the relation between credit markets and innovation. One segment of this literature explores the impact of U.S. banking deregulation on innovation. Chava et al. (2013) and Amore, Schneider and Zaldokas (2013) report an increase in patenting in some types of firms following interstate banking deregulation, which arguably increased credit supply. Cornaggia et al. (2015), however, find that although interstate branching deregulation led to more patenting by small private firms, the overall effect on state-level patenting was *negative*. In a similar vein, Berger et al. (2015) use a synthetic matching procedure and report a relative *decline* in state-level patenting following intrastate banking deregulations. Overall, these studies provide mixed evidence on the role credit markets may play in the process of innovation-led growth.

Other studies on credit markets and innovation also fail to reach a consensus. For example, Benfratello, Schiantarelli, and Sembenelli (2008) find that banking development in Italy increased the

[4] For example, see Beck and Levine (2002) and Levine (2002). Carlin and Mayer (2003) find some evidence that financial structure matters for growth, where structure is measured by proxies for information disclosure and the size and concentration of credit markets. Their study is very different from ours as they do not attempt to distinguish the role of credit versus equity market development and they do not explicitly explore the high-tech sector.

[5] A related literature examines the consequences of financial innovation for economic performance (e.g., Merton, 1992; Allen and Gale, 1994; Zarutskie, 2013). Notably, the model in Laeven, Levine, and Michalopoulos (2015) shows that technological innovation eventually stops unless financiers keep innovating. One implication of our study is that innovations expanding the supply of external equity financing should be particularly pivotal for technology-led growth.

likelihood of process innovation, Chava, Nanda, and Xiao (2015) report that loan spreads are lower for firms with greater numbers of patents, and Mann (2015) finds that court decisions strengthening creditor rights is associated with higher subsequent levels of R&D. These findings suggest bank loans can be a viable source of financing for innovation. On the other hand, a large literature shows that innovative firms use less debt than other firms (Hall, 2002), and the findings in Brown, Martinsson, and Petersen (2013) and Hsu, Tian, and Xu (2014) indicate that cross-country differences in credit market development have zero or even negative effects on innovation. More research is clearly needed to sort out how better access to credit affects innovation. Our focus differs from the existing literature in that we examine industry growth rates rather than innovative inputs (R&D) and outputs (patents). Our findings indicate that any positive benefit banking development may have on innovative activity does not typically translate into faster growth of the high-tech sector.

To clarify our contribution, it is important to point out where our paper differs from three prior studies. The study most similar to ours is Beck and Levine (2002), who also explore the impact of market- and bank-based financial development on industry expansion, including R&D-intensive industries. They find no evidence that the type of financial system matters for growth, and only limited evidence that the absolute size of financial markets matters for the expansion of R&D-intensive industries. There are several reasons why some of our findings point to different conclusions than those of Beck and Levine (2002). First, they construct an index of the extent to which countries are relatively market- or bank-based, which may not capture whether a country has a highly developed equity market or simply a particularly poorly developed credit market. Furthermore, they employ a measure of overall financial market development (stock market activity × credit market size), whereas we study the effects of stock market and credit market development separately. In addition, their tests cover industry growth rates in the 1980s, which pre-dates much of the technology-led growth at the end of the 20$^{th}$ century. Finally, the R&D intensity measure Beck and Levine (2002) use is available for less than 30% of their industries, potentially limiting their ability to identify the effects of financial market development that are specific to the high-tech sector.

Our work also differs from recent studies on stock markets and innovation.[6] Brown, Martinsson, and Petersen (2013) find that better access to stock market funding is associated with substantially higher R&D intensity in young and small firms (but not large and mature firms). They do not, however, study how finance affects the growth of high-tech industries. The lack of access to stock market funding may not matter for high-tech industry growth if mature firms largely offset any lost value added of young, financially constrained firms. Our findings, however, show that stock market development does have a substantial impact on growth at the *industry* level, a key finding for assessing the impact of financial development on aggregate economic performance.

A related study, Hsu, Tian, and Xu (2014), finds that industries that are more dependent on external finance and more high-tech intensive have higher patenting levels in countries with better developed equity markets. Like Brown, Martinsson, and Petersen (2013), Hsu, Tian, and Xu (2014) focus on the linkages between finance and inputs and outputs of innovation rather than the growth of high-tech industries. In addition, Hsu, Tian, and Xu (2014) report a *negative* and quantitatively important connection between credit market development and innovation. This is a provocative finding which requires additional study given its profound implications for the desirability of financial development in bank-based countries. Our findings show that while credit market development does not promote the expansion of the high-tech sector, it is not a major impediment either. Moreover, credit market development facilitates the expansion of non high-tech sectors, suggesting that the net effects of a larger banking sector are positive.

The next section of the paper reports information on R&D, patenting, and reliance on stock issues in high-tech industries. Section III studies the broad connections between financial market development, the high-tech sector, and aggregate economic growth. Section IV reports the difference-in-differences regressions of industry growth on equity and credit market development, the most important findings in the study. Section V examines the channels through which stock markets matter for high-tech growth, and Section VI discusses the key implications of our study.

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[6] Another recent study, Fang, Tian and Tice (2014), concludes that increased stock market liquidity, normally thought of as one measure of better functioning stock markets (e.g., Levine and Zervos, 1998), is actually harmful for innovation. They find that changes in decimalization and minimum tick sizes on U.S. exchanges (that lead to greater liquidity) are associated with a reduction in future patents and citations.

## II. Data, measurement, and R&D and financing in the high-tech sector

*A. Sample construction, main variables and high-tech definition*

Table A.I reports data sources and definitions for the main variables used in this study. Our baseline sample comprises 38 countries with sufficient coverage in the World Bank Financial Development and Structure Dataset and the UNIDO database during the period 1980 to 2005. Table A.II lists the 38 sampled countries and provides country-level statistics for the key measures of economic growth, financial development, and high-tech production. Table A.III presents pooled summary statistics for the main outcome variables we study.

We follow the empirical literature on finance and growth and use data on financial market development from the World Bank's financial development and structure dataset (Beck, Demirgüç-Kunt and Levine, 2000; Beck and Demirgüç-Kunt, 2009). To measure credit market development we use the ratio of private credit by deposit money banks to GDP (*Bank credit*), which is the most commonly used measure in the literature (e.g., Beck and Levine, 2002 and 2004; Levine and Zervos, 1998). Our main measure of stock market development is the value of the trades of shares on domestic exchanges to GDP (*Value traded*). We focus on this measure because previous studies find that stock market liquidity rather than stock market capitalization shares the strongest association with long-run growth (e.g., Levine and Zervos, 1998). This is also a key indicator used in Beck and Levine (2002) to capture equity market development in their measures of financial structure and overall financial development.

The OECD defines industries as "high-tech" based on their R&D-intensity (see Hatzichronoglou (1997) for a discussion). Throughout the study we consider Chemicals and allied products (SIC 28), Industrial machinery and equipment (SIC 35), Electronic and other electric equipment (SIC 36), and Instruments and related products (SIC 38) the high-tech industries of manufacturing. Excluding Chemicals (SIC 28), the remaining industries are the primary information and communications technology (ICT) sectors in manufacturing.[7]

[7] The two-digit sectors we focus on incorporate all of the three-digit manufacturing industries that Brown, Fazzari, and Petersen (2009) consider high-tech; namely, drugs (SIC 283), office and computing (SIC 357), communications equipment (SIC 366), electronic components (SIC 367), scientific instruments (SIC 382), and

*B. Investment, finance, and patents in the high-tech sector*

Figure 1 illustrates the importance of the high-tech sector for worldwide innovative activity. The figure plots worldwide patents filed at the USPTO during the period 1976-2007. We plot total patents filed (solid line) and patents filed from non high-tech industries (dashed line). High-tech patenting is thus reflected by the gap between the two lines. In the late 1970s and early 1980s the level of patenting is relatively stable and non high-tech industries account for the majority of patents (75-80%). But starting in the mid 1980s the difference between total patents and non high-tech patents begins to diverge, with the sharp increase in total patents being driven largely by high-tech industries. By the early 2000s the high-tech sector accounts for over 60% of all patents.

Figure 2 uses firm-level data from the US to illustrate the importance of R&D investment and stock market financing across high-tech and non-high-tech industries. To compute the values reported in Figure 2, we sum, for each publicly listed firm with coverage in the Compustat database, R&D investment, net funds raised from stock issues, and total investment (R&D plus capital spending) over the period 1980 to 2005. Using these totals, we find the R&D-to-total investment and stock issues-to-total investment ratio for each firm. Finally, we report the median firm-level ratio in each two-digit SIC industry in US manufacturing. This approach follows the method RZ use to compute industry level measures of external finance dependence in their study on finance and growth. In Figure 2, we label the R&D measure as R&D dependence and the stock market measure as External equity dependence.

In Figure 2 we sort industries from most to least R&D intensive. The top bar is the industry's R&D dependence and the bottom bar is the industry's External equity dependence. Two patterns stand out in Figure 2. First, it is clear that R&D represents a substantially larger share of total investment in the four high-tech industries than in the rest of manufacturing. Notably, R&D accounts for between 57% and 74% of total investment in the high-tech industries, but only 6% to 32% of total investment in the non high-tech industries. Second, the four high-tech industries are also the top four industries when it comes to use of stock issues. For example, across the four high-tech industries, the

medical instruments (SIC 384). Our categories are also generally consistent with other studies of the high-tech sector (e.g., Hall, Jaffe, and Trajtenberg, 2001 and 2005; Himmelberg and Petersen, 1994).

average External equity dependence ratio is 60%, highlighting the importance of external equity finance in the high-tech sector. In contrast, the corresponding average across the other manufacturing industries is only 7%.

In Figure 3 we illustrate the aggregate importance of the four high-tech industries for R&D and stock issues in the US. First, not only are firms in the high-tech sector particularly R&D intensive, but collectively they account for a large and rising share of aggregate R&D.[8] In 1980, the four high-tech industries accounted for approximately 50% of all R&D by US publicly traded firms; by 2005, this share is up to almost 80%. Furthermore, the high-tech firms' share of aggregate external equity raised on the US stock market increased from 20-30% in the early 1980's to about half of all stock issues in 2005.

The plots in Figures 2 and 3 show that high-tech firms in the U.S. rely extensively on stock issues to fund investment, which is principally R&D. But are high-tech firms in the rest of the world also dependent on external equity financing? The descriptive regressions reported in Table I indicate that they are. Working with samples of firms with coverage in the Compustat North America and Compustat Global datasets, we show how use of stock issues and leverage ratios vary across high-tech and non-high-tech firms in both the U.S. (Panel A) and in our sample of non-U.S. countries (Panel B).

In the first column, we regress each firm's average *Stock issues* ratio against an indicator for whether the firm is located in one of the four high-tech industries (HT dummy). We estimate a corresponding regression in column (2) with the R&D-to-total investment ratio for the median U.S. firm (R&D dependence) in place of the HT dummy. In Panel A, the coefficients on the HT dummy and R&D dependence variables are positive and large, indicating that the average *Stock issues* ratio is substantially larger for U.S. high-tech firms than for firms outside high-tech, as illustrated in Figure 2. For example, the average *Stock issues* ratio is over three times larger for U.S. firms in high-tech industries than for other firms (0.212 versus 0.064). The results in Panel B show a very similar pattern in the non-U.S. sample. The coefficients on the HT dummy and R&D dependence terms are once again positive and substantial, though smaller in magnitude than the corresponding regressions in

[8] These values are based on publicly listed firms in the US, where public firms account for the vast majority of R&D investment. For example, Brown, Fazzari and Petersen (2009) report that, in the year 2003, total R&D reported by firms in Compustat was approximately 90% of aggregate US industrial R&D reported by the NSF.

Panel A. The results are almost identical if we estimate the specification with a full set of country fixed effects. These results show that although average *Stock issues* ratios are smaller for non-U.S. firms – consistent with the U.S. having relatively well developed equity markets – the use of external equity is just as concentrated in the high-tech sector. Notably, the average *Stock issues* ratio in the non-U.S. sample is a little over three times larger in high-tech firms compared to other firms (0.075 versus 0.024), almost exactly mirroring the evidence for U.S. firms in Panel A.

The dependent variable in the last two regressions (columns 3 and 4) is the firm's total debt-to-assets ratio (*Leverage*). In both the U.S. and non-U.S. samples, the point estimates on the HT dummy and R&D dependence terms are negative and statistically significant, indicating relatively less use of debt finance in high-tech firms around the world. In addition, the size of the point estimates are very similar in the corresponding regressions in Panels A and B, showing that in both samples leverage ratios are around 20% lower in high-tech firms than in other firms. These findings are consistent with many other studies showing that R&D intensive, high-tech firms are substantially less leveraged than other firms (e.g., Hall, 2002).

*C. Other evidence on equity financing in the high-tech sector*

Figures 2 and 3, along with Table 1, suggest that a potentially important role for stock markets is funding the R&D of the high-tech sector. This descriptive evidence is broadly consistent with studies that directly link stock issues with R&D investment in samples of international firms. For example, Kim and Weisbach (2008) show that, around the world, a majority of the funds that firms raise in public stock issues are ultimately invested in R&D. Furthermore, Brown, Martinsson, and Petersen (2013) show that young-firm levels of R&D investment are substantially higher in countries with well-developed stock markets.

In addition to directly funding innovation, well-developed stock markets are also pivotal to venture capital (VC) and other forms of private equity finance. Several studies show that access to private equity has a positive impact on R&D and innovation, particulalry in young high-tech firms (e.g., Gompers and Lerner, 2001; Brown and Floros, 2012). We note that the rise of the VC industry correlates strongly with the rise of high-tech illustrated in Figures 2 and 3 (Kortum and Lerner, 2000).

Furthermore, Black and Gilson (1998) argue that it is likely difficult to develop an active VC industry without the lucrative exit opportunity made possible by a well-developed equity market. Indeed, for countries in our study where data on VC activity is available, the level of VC activity is highly positively correlated with stock market development but negatively correlated with credit market development.[9] The direct funding role of public equity markets, together with the indirect role they play in VC financing, suggests that stock market development may play a key role in supporting the growth of high-tech industries.

## III. Financial development, the high-tech sector, and economic growth

*A. The high-tech sector and economic growth*

Although the high-tech sector is widely viewed as a key driver of innovation and growth, to our knowledge, there is little empirical evidence linking the size of country's high-tech sector with subsequent rates of economic growth. Therefore, to further motivate our paper, we start by examining the strength of this relationship during our sample period. We follow the empirical approach in Bekaert, Harvey, and Lundblad (2011) and explore how economic covariates measured in period *t* relate to growth over the next five years. This leads to the following empirical specification:

$$y_{i,t+5,t} = \alpha Q_{i,start} + \beta High\text{-}tech\ value\ added_{i,t} + \gamma X_{i,t} + \eta_t + \varepsilon_{i,t+5,5}. \quad (1)$$

In equation (1), $y$ is economic growth, expressed as a rolling average over *t+1* to *t+5*. We focus primarily on growth in per capita GDP, though we also decompose aggregate economic growth into capital accumulation and total factor productivity (TFP) growth. On the right-hand side of the equation, $Q$ is the initial level of economic development reset at 5-year intervals, and *X* is a vector of country control variables that includes *Schooling*, *Trade*, and *Investment.*[10] In addition, $\eta$ is a set of

[9] Jeng and Wells (2000) provide data on the value of early stage VC investments-to-GDP for 19 of our sample countries during 1986-1995. The pairwise correlation (p-value) between the VC investments measure they report and *Value traded* is 0.2976 (0.0006), while the pairwise correlation (p-value) between VC investments and *Bank credit* is -0.0164 (0.8371).

[10] This country control set is essentially the same as in Bekaert, Harvey, and Lundblad (2011) with the exception that we drop life expectancy and instead include investment to GDP. We drop life expectancy from the baseline specification since our sample is comprised primarily of developed countries whereas Bekaert, Harvey, and Lundblad (2011) use a sample of 96 countries with substantial variation in life expectancy. We include investment to GDP because it has been shown to be an important determinant of long-run growth (e.g., Levine and Renelt, 1992). Our findings are robust to adding a number of additional country-level control variables

year-specific dummy variables accounting for shocks common to all countries in a given year. Our variable of interest is *High-tech value added*, which is the sum of value added coming from the four high-tech industries divided by GDP.

In Table II we report OLS estimates of equation (1) with standard errors clustered at the country level.[11] First, we note that the coefficient on initial per capita GDP is negative and significant across all specifications, and the other control variables (*Trade*, *Investment*, and *Schooling*) all have the expected signs (e.g., Barro, 1997; Barro and Sala-i-Martin, 1995). Of particular importance, the results in column (1) show that *High-tech value added* is positively and significantly related to long-run economic growth. At the bottom of the table we include what we call 'economic magnitude' to evaluate the economic importance of the coefficient estimates. The economic magnitude shows the associated change in economic growth if, all else equal, a country moves from the 25$^{th}$ percentile of *High-tech value added* to the 75$^{th}$ percentile. In column (1) the estimated magnitude of such an increase in high-tech activity is 0.4 percentage points faster GDP growth, which is sizeable relative to the sample average per capita growth rate of 2.3 percent.

In the next three columns of Table II we replace *High-tech value added* with three alternative measures of high-tech activity: *ICT value added*, *New high-tech establishments*, and *Granted high-tech patents*. (Recall that the only difference in *High-tech value added* and *ICT value added* is that the former is computed using all four high-tech industries while the later drops chemicals (SIC code 28)). The coefficient estimate on each of these alternative measures is positive and statistically different from zero.

In the final two columns of Table II we decompose long-run per capita GDP growth into capital accumulation and total factor productivity (TFP) growth. This decomposition provides an additional test: if high-tech production matters for subsequent economic growth, it should be

sometimes used in empirical growth studies, including life expectancy, the size of the government, the inflation rate, population size and growth, and degree of intellectual private property protection.

[11] We obtain similar estimation results using standard errors with a Newey and West (1987) adjustment with five lags for serial correlation (accounting for the overlapping nature of the data).

especially important for TFP growth.[12] In fact, the estimated relation between high-tech activity and TFP growth is significant at below the 1% level and the predicted impact is 36% of the sample mean TFP growth. In contrast, the coefficient estimate in the capital accumulation regression is not significant at conventional levels and its magnitude amounts to less than 10% of the mean rate of capital accumulation. These findings suggest that the connection between high-tech production and aggregate economic growth documented in the first part of Table II works primarily through TFP growth, as expected.

*B. Financial development and aggregate high-tech activity*

We now turn to the association between financial market development and growth in the size of a country's high-tech sector. Using a similar approach to equation (1), we estimate the following specification:

$$\Delta High\text{-}tech\ value\ added_{i,t+5,t} = \delta High\text{-}tech\ value\ added_{i,t} + \zeta Finance_{i,t} + \theta X_{i,t} + \eta_t + \varepsilon_{i,t+5,5}. \quad (2)$$

The dependent variable in equation (2) is *ΔHigh-tech value added*, which is the average annual growth of high-tech value added to GDP over *t+1* to *t+5* for country *i*. *X* is the same vector of country control variables used in equation (1), and $\eta$ is a set of year-specific dummy variables. The key independent variable of interest is the initial level of financial market development (*Finance*), measured by either *Value traded* or *Bank Credit*. This approach allows us to provide some suggestive evidence of the overall connection between financial development and rate of growth of the high-tech sector. (In the next section we consider a difference-in-differences approach to address concerns about reverse causality and endogeneity.)

The first regression in Table III shows a positive and statistically significant relation between initial levels of *Value traded* and subsequent growth in *High-tech value added*. The estimate suggests that moving from the 25$^{th}$ to 75$^{th}$ percentile in *Value traded* is associated with an increase in the growth of *High-tech value added* of 1.4 percentage points per year. This effect is approximately 20% of the sample mean of high-tech value added growth, suggesting that stock market development is

[12] The productivity data covers 37 countries as Germany is not available in the database. In addition, the time series ends in 2000, so the number of observations is lower in the TFP and capital accumulation regressions. We have confirmed that our baseline results in columns (1)-(4) hold in the smaller sample.

associated with an economically meaningful increase in high-tech activity. In the next column, the estimated coefficient for *Bank Credit* is negative, although not statistically significant. In the third column, including both *Value Traded* and *Bank Credit* causes the coefficient on *Value Traded* to decline slightly but the magnitude of the coefficient continues to indicate a sizeable economic relation between *Value traded* and growth in *High-tech value added*: moving from the 25$^{th}$ to 75$^{th}$ percentile in *Value traded* is associated with an increase in the growth of *High-tech value added* of 1.0 percentage points per year.

In the last three columns of Table III we modify equation (2) by replacing *ΔHigh-tech value added* with *ΔICT value added.* These regressions also show that stock markets, but not credit markets, share a positive and significant relation with growth in the high-tech sector. Notably, the coefficient estimates on *Value traded* in both column (4) and column (6) are even larger and more precisely estimated than their counterparts in columns (1) and (3).

In summary, the evidence in Table III shows that growth in the overall size of high-tech production (and especially ICT production) shares a strong positive relation with the initial level of stock market development, but not credit market development. These (non)results for *Bank credit* are of interest not only because they differ sharply from the findings for *Value traded*, but also because they suggest that unobserved factors correlated with both financial development and growth in the high-tech sector are likely not the cause of the positive results for stock market development. The reason is that such unobserved factors, if present, are unlikely to be correlated only with stock market development.

## IV. Financing technology-led growth: Difference-in-differences tests

We turn now to difference-in-differences tests, building on the approach that RZ use to identify the causal connections between financial development and growth. RZ argue that industries that are technologically more dependent on external finance should benefit more (i.e., grow faster) from financial development than industries that require relatively little external finance. Like RZ, we examine the interaction between a country's financial development and an industry's technological dependence on external finance. In addition, similar to Beck and Levine (2002), we also explore the interaction between financial development and R&D intensity, the distinguishing characteristic of high-tech industries illustrated in Figure 2.

*A. RZ dependence, R&D dependence, and growth*

RZ use firm-level data from the US to construct industry-level measures of dependence on external finance. The RZ measure is computed by summing, for each firm, the difference between fixed capital spending and operating cash flow over the 1980s, and then dividing by the sum of fixed capital spending over the same period. The RZ measure thus reflects how dependent the typical firm in an industry is on external finance to fund their fixed capital investment. We construct an identical measure for our industry groupings and call this *RZ dependence*. In addition, we use US data to construct a measure of industry R&D intensity by summing firm-level R&D expenditures over the 1980s and dividing by the sum of total investment (R&D plus capital spending) over the same interval. We then find the median value across all firms in a two-digit SIC industry and call the measure *R&D dependence*.[13]

RZ base their regressions on a pure cross section of observations across countries and industries. We continue with our approach of using pooled yearly observations and estimate the following regression:

$$\Delta Industry\ value\ added_{i,j,t+5,t} = \vartheta Industry\ value\ added_{i,j,t} + vX_{i,t} + \kappa Finance_{i,t} + \lambda(Finance_{i,t} \times RZ\ Dependence_j) + \mu(Finance_{i,t} \times R\&D\ dependence_j) + g(Finance_{i,t} \times RZ\ Dependence_j \times R\&D\ dependence_j) + \eta_i + \eta_j + \eta_t + \varepsilon_{i,j,t+5,5}. \qquad (3)$$

In equation (3), the dependent variable is average annual growth in value added-to-GDP for each industry *j* in country *i* over years *t+1* to *t+5*. On the right side of the equation we control for the industry's initial value added-to-GDP in year *t*, the same *X* vector of country control variables used in equations (1) and (2), and a full set of country, industry, and year fixed effects. The inclusion of the dummy variables thus isolates the impact the interactive variables have on industry growth relative to industry and country means. The key variables in the regression are the interactions between *Finance*

[13] This measure is constructed identically to the R&D-to-total investment values reported in Figure 2, except here we sum over 1980-1990 rather than 1980-2005. As we discuss below, the results are nearly identical if we use the 1980-2005 values to measure *R&D dependence*, or if we look at R&D relative to internal cash flow rather than R&D-to-total investment.

(either *Value traded* or *Bank credit*) and the industry dependence terms (*RZ dependence* and *R&D dependence*).

Table IV reports our main difference-in-differences results. In the first four columns we estimate equation (3) using *Value traded* as the measure of financial market development. In the first column we drop the *R&D dependence* interaction and estimate the regression with the *RZ dependence* interaction only. This specification links us directly to RZ and serves as a useful baseline for interpreting our results. The results in column (1) show a positive and statistically significant coefficient on the *Value traded* x *RZ dependence* interaction. Furthermore, the estimated coefficient indicates a substantial economic magnitude. Following RZ, we measure the economic magnitude by computing the differential effect that moving from a country at the 25$^{th}$ percentile in *Value traded* to a country at the 75$^{th}$ percentile has on the growth of an industry at the 75$^{th}$ percentile in *RZ dependence* relative to an industry at the 25$^{th}$ percentile in *RZ dependence*. We report this 'differential effect' at the bottom of the table. In column (1), the estimated differential in industry growth from an increase in *Value traded* is 1.3 percentage points, or approximately 20% of the sample average. These findings are consistent in both direction and magnitude with the results in RZ.

In column (2) we drop the *RZ dependence* interaction and estimate equation (3) with the *Value traded* x *R&D dependence* interaction instead. The coefficient estimate on the interaction term is positive and statistically significant, indicating that stock market *Value traded* has a positive differential effect on industries where R&D comprises a relatively larger share of total investment. Following the approach used above to estimate the economic magnitude of the differential effect, the coefficient estimate implies that moving from a country at the 25$^{th}$ percentile in *Value traded* to a country at the 75$^{th}$ percentile will increase the difference in industry growth between a high R&D industry (75$^{th}$ percentile in *R&D dependence*) and a low R&D industry (25$^{th}$ percentile) by 2.1 percentage points. This estimated differential effect is around 30% of the sample average industry growth rate.

In column (3) we include both the *RZ dependence* and the *R&D dependence* interaction terms. The coefficient estimate on the *RZ dependence* interaction declines to near zero (-.0006) and is insignificant. In sharp contrast, the coefficient estimate on the *R&D dependence* interaction remains unchanged and continues to be statistically significant. In column (4) we estimate the full equation (3), which includes *Value traded* interacted with both *RZ dependence* and *R&D dependence*, as well as the three-way interaction *Value traded* x *RZ dependence* x *R&D dependence*. The triple interaction term is negative but statistically insignificant and its inclusion in the regression has no impact on our inferences: the coefficient estimate on the *RZ dependence* interaction remains near zero, while the coefficient estimate on the *R&D dependence* interaction remains positive, statistically significant, and economically important.[14]

In columns (5)-(8) we estimate the same series of regressions using *Bank credit* as the measure of financial development. In column (5) we include only the *Bank credit* x *RZ dependence* interaction and, consistent with RZ, the coefficient estimate is positive, significant and the estimated differential is economically large (1.8 percentage points). Similarly, when we include only the *Bank credit* x *R&D dependence* interaction in column (6), we find a significant positive coefficient and a large estimated differential effect of *Bank credit* on growth rates in R&D-intensive industries. However, when we include *both* interaction terms in column (7), the coefficient estimate on *Bank credit* x *RZ dependence* remains unchanged while the estimated coefficient for *Bank credit* x *R&D dependence* falls by ninety percent (and is no longer significant). This pattern of results is unaffected when we include the three-way interaction *Bank credit* x *RZ dependence* x *R&D dependence* in column (8). Thus, the positive differential effect of *Bank credit* on growth in R&D-intensive industries in column (6) appears to be an artifact of the generally positive correlation between *RZ dependence* and *R&D dependence*: *Bank credit* has but a small (and insignificant) differential effect on growth rates in R&D-intensive industries once we account for industry reliance on external finance for fixed investment. This result stands in sharp contrast to the findings for *Value traded*, where the *RZ dependence* interaction becomes economically unimportant once the *R&D dependence* interaction is included in the regression.

[14] To evaluate the economic magnitude with the triple interaction term in the regression, we estimate how moving from the $25^{th}$ to $75^{th}$ percentile in *Value traded* affects the difference in industry growth between a high R&D industry ($75^{th}$ percentile in *R&D dependence*) and a low R&D industry ($25^{th}$ percentile) if *RZ dependence* is at its mean level. The *R&D dependence* differential in this case is 3.1 percentage points per year. Even if *RZ dependence* is set to the $75^{th}$ percentile and the negative (but insignificant) coefficient on the triple internaction is assumed to be meaningful, the estimated differential magnitude across high and low R&D industries is above 2 percentage points per year.

Finally, in the last column, we include both the stock market and credit market development measure, along with all relevant interactions, in the same regression. Although there is some increase in the standard errors, as expected, including all the terms in the same regression has no impact on our main inferences. Most importantly, the coefficient on *Value Traded* x *R&D dependence* is positive, statistically significant, and similar in magnitude to the baseline estimate in column (2), while the coefficient for *Bank Credit* x *R&D dependence* remains near zero (-0.0030).

Overall, the findings in Table IV suggest that stock market development is important for the growth of R&D intensive industries, and credit market development matters for the growth of industries that require external finance to fund fixed investment. As noted in the introduction, these findings point in a different direction to the conclusions in Beck and Levine (2002). The two studies are not, of course, directly comparable because Beck and Levine (2002) are interested in the effects of having a *comparatively* large equity market, rather than the separate effects of stock market versus credit market development. They do, however, find no evidence that financial structure matters for industry growth and only limited evidence that financial market development matters for R&D-intensive industries. In the remainder of the paper we explore the robustness and implications of the connection between stock market development and growth in high-tech industries.

*B. Robustness checks of difference-in-differences findings*

In Table V we explore a number of alternative specifications to further evaluate the robustness of our evidence connecting stock markets to the growth of high-tech industries. We exclude the *Value Traded* x *RZ dependence* interaction term as it had no impact on our estimates or inferences about the link between stock market development and growth in R&D intensive sectors (we also note that none of the following robustness results are qualitatively impacted if the RZ interaction is included in the regression). In columns (1) and (2) we report results using alternative measures of *R&D dependence*. First, we compute the R&D dependence measure with data covering our full sample period (1980 to 2005) rather than the 1980s, as done in our main measure. The results in column (1) show a positive and significant coefficient on the interaction term, and the estimated differential is similar in magnitude to the corresponding differential reported in the second column in Table IV.

In column (2), we employ an entirely different measure of R&D dependence: instead of the R&D-to-total investment ratio, we measure *R&D dependence* as the *R&D-to-cash flow* ratio. To compute this ratio, we sum both R&D and cash flow for each firm over the period 1980-1990 and use the median ratio in each two-digit industry as our measure of R&D dependence. This measure is attractive because a higher value indicates that, for the typical firm in a given industry, R&D is large relative to cash flow, and thus external finance should be more important for funding R&D. Column (2) shows that we find very similar results with this alternative measure of R&D dependence: stock market development has a strong, positive differential effect on industries with relatively high *R&D-to-cash flow* values.

Next, we explore alternative measures of an industry's innovation-intensity and technological importance. In columns (3) and (4), we use industry measures of patenting activity taken from Hsu, Tian, and Xu (2014) as replacements for our measure of *R&D dependence*. In particular, in column (3) we use a measure based on a count of industry patents (*Patent count*), and in column (4) we use a measure based on an industry's patent citations (*Patent citations*). In both cases we find a positive and significant coefficient on the interaction between *Value traded* and patenting activity, indicating that stock markets are relatively more important for growth in more patent-intensive industries. The magnitude of the differential effect is sizeable and consistent with our other estimates, which is not surprising given the strong positive correlation between R&D intensity and patenting activity across industries.[15]

In the next two columns of Table V, rather than sort industries by a continuous measure of innovative intensity that differs across all industries, we sort simply by whether or not the industry is one of the four two-digit SIC high-tech industries. In column (5) we interact *Value traded* with a dummy variable equal to one if the industry is one of the four high-tech industries (*HT*), and in column (6) we do the same with a dummy variable indicating one of the three ICT industries (*ICT*). In each

[15] For example, across the industries in our sample the correlation between *R&D dependence* and *Patent count* is 0.890, and the correlation between *R&D dependence* and *Patent citations* is 0.877.

case, the estimated coefficient on the interaction term is positive and significant, showing that *Value traded* has a positive differential effect on growth rates in the *HT* sector and the somewhat more narrowly defined *ICT* sector. Furthermore, the magnitude of this estimated effect is substantial: if we move from a country at the 25$^{th}$ percentile in *Value traded* to the 75$^{th}$ percentile, the difference in growth rates in the *HT* (*ICT*) sector compared to the non-*HT* (non-*ICT*) sector increases by 2.0 (2.2) percentage points.

In the last two columns, we explore two alternative measures of stock market development on the growth of R&D intensive industries. The first measure is commonly refered to as *Turnover*, which is the value of trades on domestic exchanges to stock market capitalization. Like *Value Traded*, *Turnover* is a measure of stock market liquidity. The second measure is *Market capitalization*, which is the value of listed domestic shares on domestic exchanges to GDP. In column (7), the coefficient on *Turnover* x *R&D Dependence* is positive and statistically significant at conventional levels, and the coefficient estimate indicates a differential growth rate across high and low R&D industries of 1.6 percentage points per year. In column (8), the coefficient on *Market Cap* x *R&D Dependence* is marginally statistically significant and the differential in growth rate value is 1.8.[16] Overall, the quantitative effects for *Turnover* and *Market Cap* are similar to the findings for *Value Traded* reported in Table IV.

## V. Decomposition of channels through which stock markets facilitate high-tech growth

### *A. Total factor productivity versus capital accumulation*

We now consider different channels through which stock market development facilitates growth of high-tech industries. We begin by decomposing industry growth into fixed capital accumulation (ΔCap) and growth in total factor productivity (ΔTFP). If stock markets have a comparative advantage in funding intangible assets such as R&D, the effects of stock market development on high-tech growth should work through productivity growth rather than fixed capital accumulation.

[16] Like a number of studies (e.g., Levine and Zervos, 1998; Demirgüç-Kunt and Maksimovic, 1998; Beck and Levine, 2004; McLean, Zhang, and Zhao, 2012; Brown, Martinsson, and Petersen, 2013), we find weaker and less robust results if we use market capitalization to measure stock market development rather than a measure designed to capture the liquidity of stock markets.

In Table VI, columns (1), (3) and (5) report regressions with ΔTFP as the dependent variable.[17] Column (1) explores the interaction between *Value Traded* and *R&D Dependence,* column (3) replaces *R&D Dependence* with the *HT* dummy, and column (5) replaces *R&D Dependence* with the *ICT* dummy. In each of these regressions, the *Value Traded* interaction is positive, quantitatively important, and statistically significant at conventional levels. The growth differentials reported at the bottom of the table indicate that if we move from the 25th to the 75th percentile in *Value traded*, the difference in ΔTFP across high- and low-technology industries increases by 0.5 percentage points.

Columns (2), (4) and (6) report corresponding regressions with ΔCap instead of ΔTFP as the dependent variable. In each of these regressions, the estimated coefficient on the interaction of *Value traded* with either *R&D dependence*, *HT* or *ICT*, is close to zero and always statistically insignificant. The clear conclusion from Table VI is that the channel through which stock market development matters for growth in the high-tech sector is through faster total factor productivity growth, not more rapid accumulation of fixed capital.

*B. Number versus size of firms*

The second decomposition we consider is whether stock market development matters for high-tech growth by facilitating an expansion in the number of firms (extensive margin) or growth in the size of the average firm (intensive margin). RZ considered this decomposition and found that financial development facilitated growth primarily along the extensive margin. Following our prior approach, we measure the growth in the number of establishments (Δ*Number of firms*) as the average annual log change in the number of establishements for each industry *j* in country *i* over years *t+1* to *t+5*. Growth in the average size of establishments (Δ*Size of firms*) is computed as the log difference in industry employment divided by the number of establishments for each industry *j* in country *i* over years *t+1* to *t+5*.

In Table VII, columns (1), (3) and (5) report regression results where Δ*Number of firms* is the dependent variable, while columns (2), (4) and (6) report results where Δ*Size of firms* is the dependent

[17] We construct the ΔTFP variable by capturing the residuals from a regression of annual growth in industry value added against capital formation and employment growth (e.g., Savvides and Zachariadis, 2005). The sample size declines somewhat in these regressions due to missing information on capital formation and employment.

variable. The organization of Table VII is similar to Table VI in that we are focusing on *Value Traded* x *R&D Dependence* in the first pair of regressions, *Value Traded* x *HT* in the second pair, and *Value Traded* x *ICT* in the last pair of regressions. In the three regressions exploring $\Delta$*Number of firms*, the key interactions are all positive, statistically significant, and indicate a quantitively important relation between *Value traded* and growth in the number of high-tech firms. For the regressions exploring $\Delta$*Size of firms*, on the other hand, the estimated coefficients on the interaction term are marginally significant in only one regression and always indicate a smaller economic magnitude than the corresponding regression where $\Delta$*Number of firms* is the dependent variable. Together, these results suggest that the effect of stock market development on the growth of high-tech industries works primarily through an expansion in the number of firms. Thus, consistent with the broad evidence on financial development and industry growth in RZ, we find that the link between stock market development the growth of the high-tech sector works primarily through the extensive margin.

## VI. Summary and implications

This paper explores the role of financial market development for supporting the growth of the high-tech sector. We report three findings useful for motivating our main inquiry: i) countries with larger high-tech sectors exhibit faster *future* rates of economic growth, ii) there is a strong association between equity market development and the overall growth of an economy's high-tech sector, and iii) credit markets are unrelated to the growth of economy-wide high-tech production. Our main empirical evidence is based on difference-in-differences regressions of industry growth on financial market development. We include the standard RZ measure of an industry's dependence on external finance to fund fixed investment as well as a measure of industry R&D dependence. We find that credit market development has a positive differential effect on the growth of industries with high RZ financial dependence, while stock market development has a positive differential effect on high-tech industries, the sector that accounts for most of the R&D in modern economies. The main channels through which stock market development supports the growth of high-tech industries are more rapid total factor productivity and higher growth in the number of new firms. In addition, stock market development becomes more important for high-tech growth as countries move closer to the technological frontier.

Our findings have a number of implications and contribute to multiple literatures. First, our study adds to the surprisingly small literature exploring the causal linkages between stock market development and growth using disaggregated data. While recent studies show that better developed stock markets appear to be important for innovation inputs (Brown, Martinsson, and Petersen, 2013) and innovation outputs (Hsu, Tian, and Xu, 2014), these studies do not explore whether stock markets matter for the growth of high-tech industries, crucial information for assessing the impact of stock markets on aggregate economic performance. Our evidence linking stock markets with growth of the high-tech sector sheds light on the mechanism underlying the strong connection between stock markets and aggregate growth in studies that use country-level data (e.g., Levine and Zervos, 1998; Beck and Levine, 2004) and provides one explanation for why financial development appears to promote growth by increasing productivity (e.g., Baier, Dwyer Jr., and Tamura, 2004; Levine, 2005).

Second, our study provides insights into the ongoing debate concerning the role credit markets play in supporting innovation. As noted in the introduction, a number of recent studies find that better access to credit benefits innovation, while other studies report zero or even negative effects. Though our focus on industry growth differs from most this recent literature, our findings show that credit market development does not spur growth in innovative-intensive industries, though it does not appear to be a major constraint on high-tech growth either.

Third, our findings are useful for understanding when (and why) the *nature* of financial development is likely to matter for economic performance. Consistent with prior studies (e.g., RZ, 1998), if we look only at industry dependence on external finance to fund fixed capital accumulation we find that both stock markets and credit markets foster growth, highlighting the importance of financial development in general for economic performance. But when we also consider an industry's innovative intensity, we find that credit markets facilitate growth in sectors that depend on external funds for fixed capital accumulation, while only equity markets are associated with growth in technology-intensive industries. This finding suggests that equity markets become ever more important as the high-tech sector emerges as a leading driver of economic growth. As a consequence, our findings help explain why stock markets appear to be more important for growth in more advanced economies (e.g., Demirgüç-Kunt, Feyen and Levine, 2013): the high-tech sector propels growth in these economies and credit markets are not as well suited for funding this sector.

If the above conclusions are correct, they add an important qualification to the prevailing view that for a given level of financial development, whether a country is bank- or market-based does not have a substantial impact on the real side of the economy (e.g., see the review in Levine, 2005). Instead, our findings imply that financial architecture does sometimes matter, but its impact depends on the inputs driving growth and overall state of economic development. Thus, our results are consistent with Tadesse (2002), who finds that countries with more developed financial sectors grow faster from having a market-based financial system, and Demirgüç-Kunt, Feyen, and Levine (2013), who show that as countries develop, securities markets grow in importance for future economic growth.

Our insights are also broadly related to the work by Allen and Gale (1999 and 2000), Rousseau and Sylla (2005), and Rajan (2012). In particular, Rousseau and Sylla (2005) show that the establishment of a well-functioning financial system predated the expansion of canals, railroads, and other paradigm altering developments in the US, which they interpret as evidence that finance leads growth. In the last four decades, the rise of the high-tech sector is a new paradigm shift in the global economy, and our evidence suggests that equity markets played an important role in funding its development.

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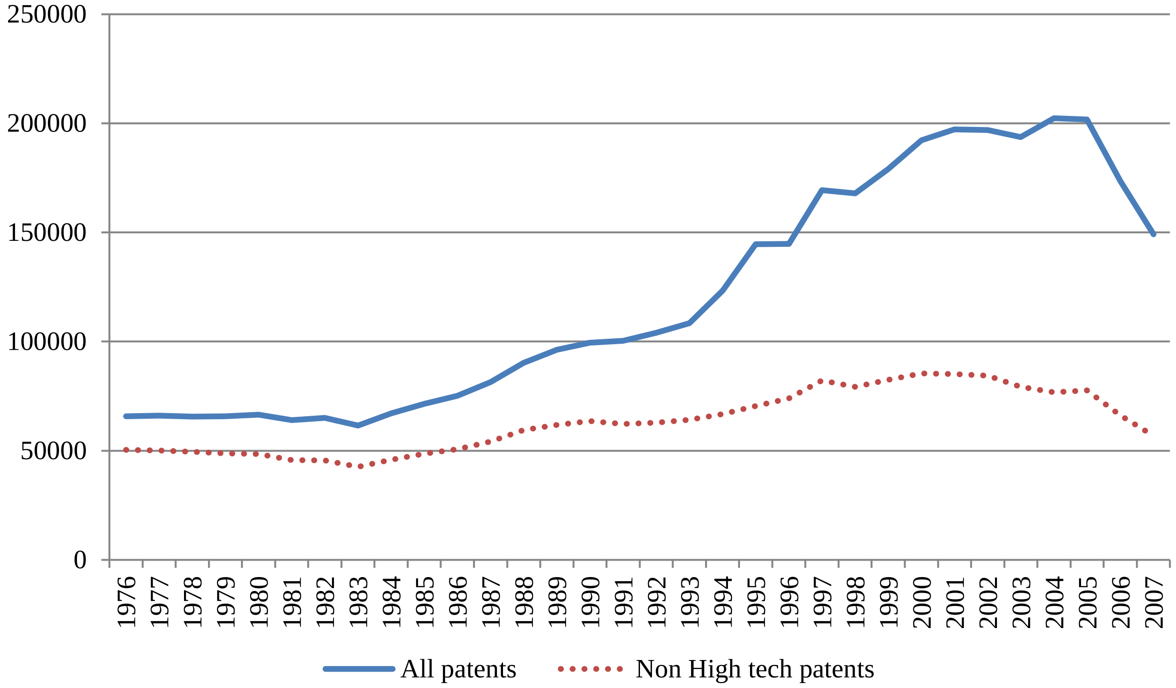


**Figure 1. Worldwide patent grants (dated at application date) at the United States Patent and Trademark Office (1976-2007).**

The solid line represents all granted patents at the United States Patent and Trademark Office (USPTO) during the period 1976-2007. The dashed line is the number of granted patents in non high-tech industries only.

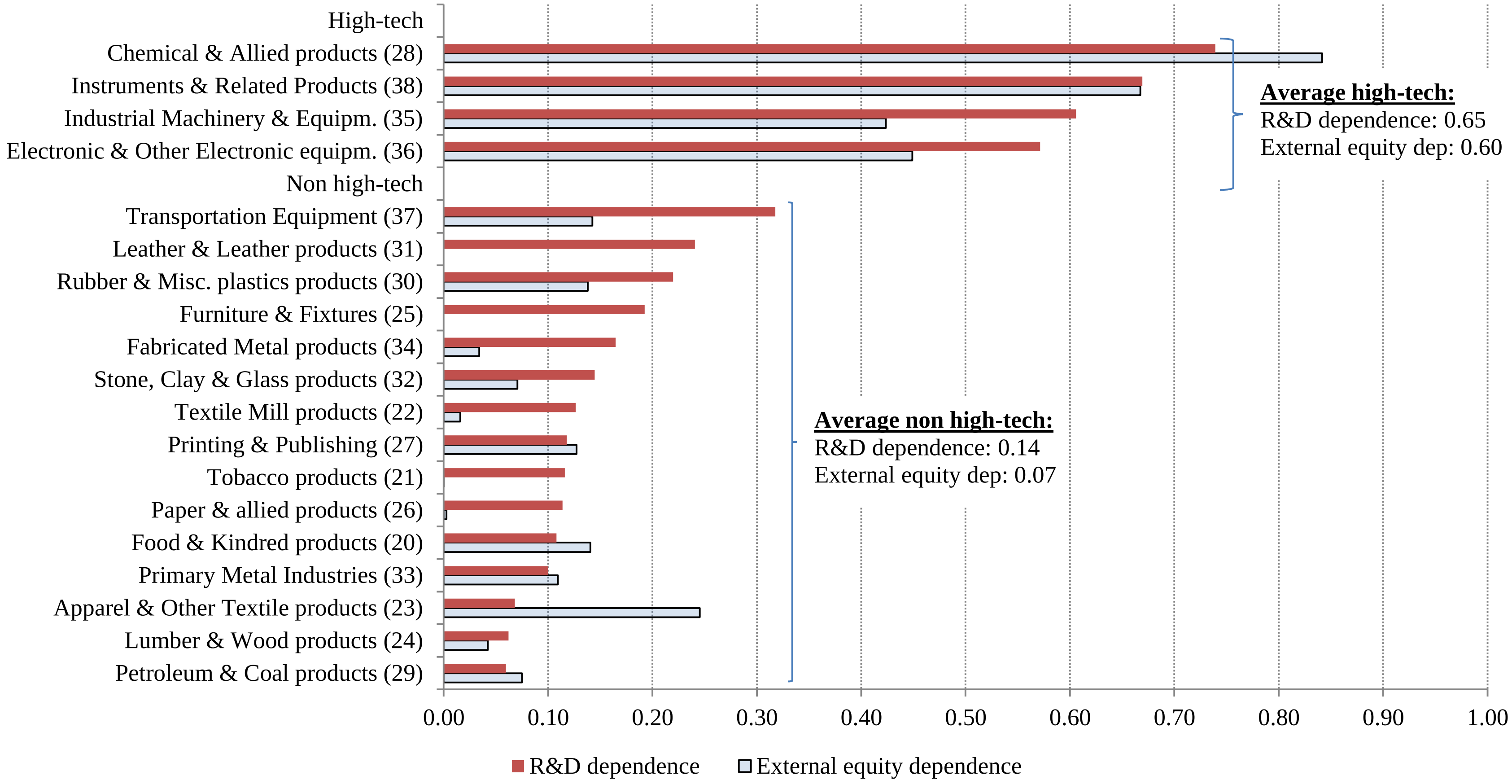


**Figure 2. R&D and external equity dependence across US manufacturing industries (1980-2005).**

Figure 2 reports R&D dependence (measured as R&D-to-total investment) and External equity dependence (Net stock issues to total investment) for the median firm in each two digit SIC industry over the 1980-2005 period.

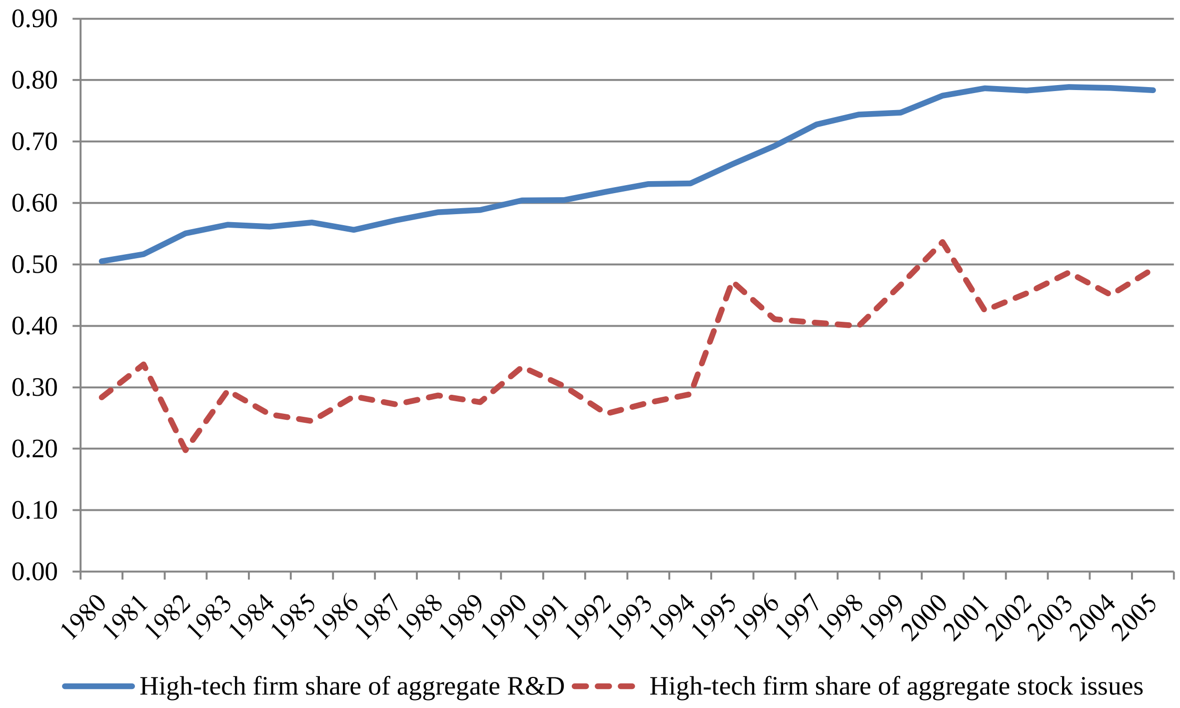


**Figure 3. Rise of high-technology in the US (1980-2005).**

The solid line is the fraction of aggregate R&D from all US firms in Compustat North America accounted for by firms in the four high-tech industries (SIC 28, 35, 36, and 38). The dashed line is the fraction of aggregate net stock issues accounted for by high-tech firms.

# Table I

## External finance in high-tech firms

Table I reports OLS regressions with firm *Stock issues* as the dependent variable in columns 1 and 2 and firm *Leverage* in columns 3 and 4. The sample in panel A consists of US firms with coverage in Compustat. The sample in panel B consists of non-US firms with coverage in Compustat Global for the 38 countries in our sample. The HT differential in column 1 (3) reflects the change in the average *Stock issues* (*Leverage*) ratio when the HT dummy moves from 0 to 1 as a fraction of the overall sample average *Stock issues* (*Leverage*) ratio. The HT differential in column 2 (4) reflects the change in the average *Stock issues* (*Leverage*) ratio when an industry is at the 75$^{th}$ percentile in R&D dependence rather than the 25$^{th}$ percentile as a fraction of the overall sample average. Robust standard errors are in parenthesis. In Panel B standard errors are clustered by country. All variables are described in Table A.I.

| Dependent variable: | Stock issues | | Leverage | |
|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** |
| *Panel A: US sample* | | | | |
| HT dummy | 0.148 | - | -0.065 | - |
| | (0.006) | | (0.007) | |
| R&D dependence | - | 0.394 | - | -0.169 |
| | | (0.015) | | (0.019) |
| Constant | 0.064 | 0.013 | 0.361 | 0.382 |
| | (0.003) | (0.005) | (0.005) | (0.007) |
| HT differential | 0.94 | 0.47 | -0.20 | -0.10 |
| Observations | 7,340 | 7,340 | 7,346 | 7,346 |
| *Panel B: Global sample* | | | | |
| HT dummy | 0.051 | - | -0.063 | - |
| | (0.018) | | (0.003) | |
| R&D dependence | - | 0.138 | - | -0.175 |
| | | (0.049) | | (0.009) |
| Constant | 0.024 | 0.007 | 0.290 | 0.313 |
| | (0.006) | (0.002) | (0.002) | (0.003) |
| HT differential | 1.09 | 0.55 | -0.24 | -0.13 |
| Observations | 10,448 | 10,448 | 10,453 | 10,453 |

## Table II

## High-tech sector activity and long-run economic growth

Table II reports OLS regressions with 5-year overlapping average GDP per capita growth as the dependent variable in columns 1-4 and TFP in column 5, and capital accumulation in column 6. Year-specific dummy variables and country control variables (Schooling, Trade, and Investment) are included in all regressions. The regressions cover 1980-2005. The economic magnitude measures the percentage point difference in GDP per capita, TFP, or Capital stock growth if the country at the 25$^{th}$ percentile in terms of high-tech sector activity moved to the 75$^{th}$ percentile of high-tech sector activity. Standard errors are clustered at the country level. All variables are described in Table A.I.

| Dependent variable: | ΔGDP per capita | | | | ΔTFP | ΔCapital accumulation |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| High-tech value added | 0.0032 | - | | - | 0.0025 | 0.0014 |
| | (0.0010) | | | | (0.0007) | (0.0012) |
| ICT value added | - | 0.0031 | | - | - | - |
| | | (0.0009) | | | | |
| New high-tech establishments | - | - | 0.0031 | - | - | - |
| | | | (0.0013) | | | |
| Granted high-tech patents | - | - | | 0.0018 | - | - |
| | | | | (0.0005) | | |
| Initial GDP per capita | -0.0169 | -0.0174 | -0.0154 | -0.0214 | -0.0083 | -0.0246 |
| | (0.0066) | (0.0067) | (0.0064) | (0.0058) | (0.0046) | (0.0070) |
| Trade | 0.0093 | 0.0095 | 0.0148 | 0.0135 | 0.0043 | 0.0049 |
| | (0.0021) | (0.0023) | (0.0032) | (0.0026) | (0.0019) | (0.0047) |
| Investment | 0.0076 | 0.0077 | 0.0080 | 0.0152 | -0.0011 | 0.0409 |
| | (0.0088) | (0.0087) | (0.0077) | (0.0055) | (0.0064) | (0.0086) |
| Schooling | 0.0131 | 0.0114 | 0.0138 | 0.0090 | 0.0073 | 0.0142 |
| | (0.0097) | (0.0099) | (0.0095) | (0.0083) | (0.0064) | (0.0121) |
| Economic magnitude | 0.4 | 0.6 | 0.6 | 0.9 | 0.4 | 0.2 |
| Sample average | 2.3 | 2.3 | 2.3 | 2.3 | 1.2 | 2.5 |
| Observations | 614 | 604 | 565 | 572 | 475 | 475 |

# Table III

## Financial market development and growth in high-tech

Table III reports OLS regressions with 5-year overlapping average ΔHigh-tech value added as the dependent variable in columns 1-3 and ΔICT value added in columns 4-6. Year-specific dummy variables and country control variables (Schooling, Trade, and Investment) are included in all regressions. The regressions cover 1980-2005. The economic magnitude measures the percentage point difference in ΔHigh-tech value added or ΔICT value added if the country at the 25$^{th}$ percentile in terms of *Value traded (Bank credit)* moved to the 75$^{th}$ percentile. Standard errors are clustered at the country level. All variables are described in Table A.I.

| Dependent variable: | ΔHigh-tech value added | | | ΔICT value added | | |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Value traded | 0.0208 | - | 0.0148 | 0.0287 | - | 0.0205 |
| | (0.0110) | | (0.0095) | (0.0088) | | (0.0094) |
| Bank credit | - | -0.0130 | -0.0158 | - | -0.0118 | -0.0154 |
| | | (0.0271) | (0.0273) | | (0.0229) | (0.0227) |
| Initial High-tech value added | -0.1049 | -0.0604 | -0.0728 | - | - | - |
| | (0.0138) | (0.0155) | (0.0194) | | | |
| Initial ICT value added | - | - | - | -0.1048 | -0.0601 | -0.0752 |
| | | | | (0.0102) | (0.0134) | (0.0162) |
| Trade | -0.0055 | 0.0100 | 0.0060 | 0.0032 | 0.0147 | 0.0102 |
| | (0.0408) | (0.0250) | (0.0262) | (0.0277) | (0.0216) | (0.0212) |
| Investment | 0.0746 | 0.0373 | 0.0578 | 0.0732 | 0.0371 | 0.0577 |
| | (0.0486) | (0.0366) | (0.0381) | (0.0410) | (0.0361) | (0.0353) |
| Schooling | -0.0335 | -0.0145 | -0.0384 | 0.0459 | 0.0344 | 0.0152 |
| | (0.0491) | (0.0430) | (0.0362) | (0.0464) | (0.0519) | (0.0433) |
| Economic magnitude | | | | | | |
| Value traded | 1.4 | - | 1.0 | 1.9 | - | 1.3 |
| Bank credit | - | -0.4 | -0.5 | - | -0.4 | -0.5 |
| Observations | 543 | 550 | 520 | 528 | 535 | 505 |

## Table IV

## Financial development and industry growth: Difference-in-difference tests

Table IV reports OLS regressions with 5-year overlapping average Δ Industry value added as the dependent variable at the industry-country-year level. The time period is 1980-2005. In addition to the reported coefficients, each regression includes country, industry, and year fixed effects and country-level control variables (Schooling, Trade and Investment). The differential in growth rate measures the difference in RZ dependence (R&D dependence) between an industry at the 75th percentile level of RZ dependence (R&D dependence) with respect to an industry at the 25th percentile level when it is located in a country at the 75th percentile of financial development rather than in one at the 25th percentile. Standard errors are clustered at the country level. All variables are described in Table A.I.

| Dependent variable: | ΔIndustry value added | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** |
| Industry value added | -0.0668 | -0.0670 | -0.0670 | -0.0670 | -0.0490 | -0.0483 | -0.0490 | -0.0490 | -0.0551 |
| | (0.0245) | (0.0244) | (0.0245) | (0.0245) | (0.0183) | (0.0181) | (0.0183) | (0.0183) | (0.0170) |
| Value traded | 0.0226 | 0.0173 | 0.0171 | 0.0160 | - | - | - | - | 0.0100 |
| | (0.0128) | (0.0129) | (0.0130) | (0.0132) | | | | | (0.0110) |
| Value traded × RZ dependence | 0.0098 | - | -0.0006 | 0.0042 | - | - | - | - | 0.0006 |
| | (0.0020) | | (0.0052) | (0.0091) | | | | | (0.0069) |
| Value traded × R&D dependence | - | 0.0263 | 0.0273 | 0.0390 | - | - | - | - | 0.0246 |
| | | (0.0116) | (0.0137) | (0.0196) | | | | | (0.0141) |
| Value traded × RZ x R&D | - | - | | -0.0333 | - | - | - | - | -0.0189 |
| | | | | (0.0368) | | | | | (0.0307) |
| Bank Credit | - | - | - | - | 0.0017 | -0.0100 | 0.0006 | -0.0002 | 0.0032 |
| | | | | | (0.0240) | (0.0204) | (0.0222) | (0.0213) | (0.0247) |
| Bank Credit × RZ dependence | - | - | - | - | 0.0362 | - | 0.0342 | 0.0427 | 0.0446 |
| | | | | | (0.0140) | | (0.0170) | (0.0343) | (0.0343) |
| Bank Credit × R&D dependence | - | - | - | - | - | 0.0558 | 0.0057 | 0.0180 | -0.0030 |
| | | | | | | (0.0294) | (0.0360) | (0.0425) | (0.0324) |
| Bank Credit × RZ x R&D | - | - | - | - | - | - | - | -0.0449 | -0.0361 |
| | | | | | | | | (0.1108) | (0.1079) |
| Differential in growth rate | | | | | | | | | |
| Stock market | | | | | | | | | |
| RZ dependence | 1.3 | - | -0.1 | -0.5 | - | - | - | - | -0.5 |
| R&D dependence | - | 2.1 | 2.2 | 3.1 | - | - | - | - | 2.0 |
| Credit market | | | | | | | | | |
| RZ dependence | - | - | - | - | 1.8 | - | 1.7 | 1.6 | 1.8 |
| R&D dependence | - | - | - | - | - | 1.8 | 0.2 | 0.6 | -0.1 |
| Observations | 8821 | 8821 | 8821 | 8821 | 8923 | 8923 | 8923 | 8923 | 8464 |

# Table V

## Stock markets and technology-led growth: Robustness checks

Table V reports OLS regressions with average growth in Industry value added over rolling 5-year periods as the dependent variable. The time period is 1980-2005. In addition to the reported coefficients, each regression includes country, industry, and year fixed effects, as well as a set of time-varying country-level control variables (Schooling, Trade and Investment).The differential in growth rate measures the predicted difference in growth for an industry at the 75$^{th}$ percentile in sector dependence compared to an industry at the 25$^{th}$ percentile level when it is located in a country at the 75$^{th}$ percentile of Value traded rather than in one at the 25$^{th}$ percentile. Standard errors are clustered at the country level. All variables are described in Table A.I.

| Dependent variable: | ΔIndustry value added | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** |
| | Alternative measures of R&D dependence | | Industry innovative intensity using patent measures | | HT and ICT industries | | Alternative measures of stock market development | |
| Industry value added | -0.0669 | -0.0669 | -0.0669 | -0.0669 | -0.0669 | -0.0668 | -0.0632 | -0.0605 |
| | (0.0244) | (0.0244) | (0.0244) | (0.0245) | (0.0244) | (0.0245) | (0.0246) | (0.0269) |
| Value traded | 0.0185 | 0.0180 | 0.0202 | 0.0203 | 0.0207 | 0.0211 | - | - |
| | (0.0129) | (0.0130) | (0.0128) | (0.0128) | (0.0128) | (0.0128) | | |
| Turnover | - | - | - | - | - | - | 0.0283 | - |
| | | | | | | | (0.0185) | |
| Market capitalization | - | - | - | - | - | - | - | 0.0037 |
| | | | | | | | | (0.0131) |
| Value traded × R&D dependence (1980-2005) | 0.0187 | - | - | - | - | - | - | - |
| | (0.0076) | | | | | | | |
| Value traded × R&D-to-cash flow | - | 0.0135 | - | - | - | - | - | - |
| | | (0.0058) | | | | | | |
| Value traded × Patent count | - | - | 0.0076 | - | - | - | - | - |
| | | | (0.0035) | | | | | |
| Value traded × Patent citations | - | - | - | 0.0006 | - | - | - | - |
| | | | | (0.0003) | | | | |
| Value traded × HT | - | - | - | - | 0.0084 | - | | - |
| | | | | | (0.0039) | | | |
| Value traded × ICT | - | - | - | - | - | 0.0092 | - | - |
| | | | | | | (0.0047) | | |
| Turnover × R&D dependence | - | - | - | - | - | - | 0.0408 | - |
| | | | | | | | (0.0201) | |
| Market cap × R&D dependence | - | - | - | - | - | - | - | 0.0332 |
| | | | | | | | | (0.0178) |
| Differential in growth rate: | 2.7 | 2.0 | 1.2 | 1.3 | 2.0 | 2.2 | 1.6 | 1.8 |
| Observations | 8821 | 8821 | 8821 | 8821 | 8821 | 8821 | 8709 | 8859 |

# Table VI

## Stock markets and growth: Productivity versus capital accumulation

Table VI reports OLS regressions with industry-level productivity growth (ΔTFP) or capital accumulation (ΔCap) as the dependent variable. The time period is 1980-2005. In addition to the reported coefficients, each regression includes country, industry, and year fixed effects, as well as a set of time-varying country-level control variables (Schooling, Trade and Investment). In columns 1 and 2 the differential in growth rate measures the difference in growth between an industry at the 75$^{th}$ percentile level of R&D dependence with respect to an industry at the 25$^{th}$ percentile level when it is located in a country at the 75$^{th}$ percentile of Value traded rather than in one at the 25$^{th}$ percentile. In columns 3-4 (5-6) the differential in growth rate measures the difference in growth between HT (ICT) and non-HT (non-ICT) sectors in a country at the 75$^{th}$ percentile of Value traded rather than in one at the 25$^{th}$ percentile. Standard errors are clustered at the country level. All variables are described in Table A.I.

| Dependent variable: | ΔTFP | ΔCap | ΔTFP | ΔCap | ΔTFP | ΔCap |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Industry value added | -0.0109 | 0.0024 | -0.0109 | 0.0024 | -0.0109 | 0.0028 |
| | (0.0041) | (0.0064) | (0.0040) | (0.0064) | (0.0040) | (0.0064) |
| Value traded | -0.0040 | 0.0019 | -0.0033 | 0.0021 | -0.0032 | 0.0026 |
| | (0.0031) | (0.0082) | (0.0029) | (0.0085) | (0.0029) | (0.0087) |
| Value traded × R&D dependence | 0.0060 | 0.0017 | - | - | - | - |
| | (0.0018) | (0.0084) | | | | |
| Value traded × HT | - | - | 0.0020 | 0.0005 | - | - |
| | | | (0.0007) | (0.0029) | | |
| Value traded × ICT | - | - | - | - | 0.0025 | -0.0040 |
| | | | | | (0.0006) | (0.0023) |
| Differential in growth rate | | | | | | |
| R&D dependence | 0.5 | 0.1 | - | - | - | - |
| HT | - | - | 0.5 | 0.1 | - | - |
| ICT | - | - | - | - | 0.6 | -1.0 |
| Observations | 5629 | 6753 | 5629 | 6753 | 5629 | 6753 |

# Table VII

## Stock markets and growth: Number versus size of firms

Table VII reports OLS regressions with industry-level growth in either the number of firms (ΔNr of firms) or average size of firms (ΔSize of firms) as the dependent variable. The time period is 1980-2005. In addition to the reported coefficients, each regression includes country, industry, and year fixed effects, as well as a set of time-varying country-level control variables (Schooling, Trade and Investment). In columns 1 and 2 the differential in growth rate measures the difference in growth between an industry at the 75$^{th}$ percentile level of R&D dependence with respect to an industry at the 25$^{th}$ percentile level when it is located in a country at the 75$^{th}$ percentile of Value traded rather than in one at the 25$^{th}$ percentile. In columns 3-4 (5-6) the differential in growth rate measures the difference in growth between HT (ICT) and non-HT (non-ICT) sectors in a country at the 75$^{th}$ percentile of Value traded rather than in one at the 25$^{th}$ percentile. Standard errors are clustered at the country level. All variables are described in Table A.I.

| Dependent variable: | ΔNr of firms | ΔSize of firms | ΔNr of firms | ΔSize of firms | ΔNr of firms | ΔSize of firms |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Number of establishments | -0.0530 | - | -0.0527 | - | -0.0530 | - |
| | (0.0107) | | (0.0107) | | (0.0108) | |
| Average size of establishment | - | -0.0601 | - | -0.0601 | - | -0.0600 |
| | | (0.0105) | | (0.0105) | | (0.0105) |
| Value traded | -0.0016 | -0.0047 | 0.0003 | -0.0043 | 0.0003 | -0.0040 |
| | (0.0104) | (0.0065) | (0.0103) | (0.0066) | (0.0103) | (0.0066) |
| Value traded × R&D dependence | 0.0146 | 0.0035 | - | - | - | - |
| | (0.0041) | (0.0035) | | | | |
| Value traded × HT | - | - | 0.0040 | 0.0019 | - | - |
| | | | (0.0014) | (0.0011) | | |
| Value traded × ICT | - | - | - | - | 0.0061 | -0.0002 |
| | | | | | (0.0022) | (0.0011) |
| Differential in growth rate | | | | | | |
| R&D dependence | 1.2 | 0.3 | - | - | - | - |
| HT | - | - | 1.0 | 0.5 | - | - |
| ICT | - | - | - | - | 1.5 | 0.0 |
| Observations | 7971 | 7543 | 7971 | 7543 | 7971 | 7543 |

## Table A.I

## Description of the variables and their sources

| Variable | Source | Description |
|---|---|---|
| RD dependence | Compustat North America | Ratio of R&D to total investment (R&D plus fixed investment) for the median US firm in each two-digit SIC industry over 1980-1990. |
| RZ dependence | Compustat North America | External finance dependence for the median US firm in a given industry over 1980-1990. Computed as in Rajan and Zingales (1998): ratio of (Capital expenditures – operating cash flow) to capital expenditures. |
| R&D-to-cash flow | Compustat North America | Ratio of R&D to cash flow for the median US firm in each two-digit SIC industry. |
| External equity dependence | Compustat North America | Ratio of net stock issues to total investment for the median US firm in each two-digit SIC industry. |
| Stock issues | Compustat N.A. and Global | The average ratio of net stock issues (gross share issues minus stock buybacks) to total assets for a given firm over the sample period. |
| Leverage | Compustat N.A. and Global | The average ratio of total debt (long-term debt plus debt in current liabilities) to total assets for a given firm over the sample period. |
| Patent count | Hsu, Tian, Xu (2014) | Count of patents granted to US firms in a given industry |
| Patent citations | Hsu, Tian, Xu (2014) | Count of citations to patents held by US firms in a given industry |
| GDP per capita growth | Penn World Table | Moving average from t+1 to t+5 of annual difference in log GDP per capita |
| TFP growth | UN Productivity Database | Moving average from t+1 to t+5 of annual difference in log Total Factor Productivity |
| Capital stock per capita growth | UN Productivity Database | Moving average from t+1 to t+5 of annual difference in log capital stock per capita |
| Initial GDP per capita | Penn World Table | Log GDP per capita reset at t-5 intervals |
| Schooling | Barro-Lee (2013) Education attainment dataset | Log of average years of secondary schooling attained |
| Trade | World Bank Development indicators | Trade is the sum of exports and imports of goods and services measured as % of GDP |
| Investment | World Bank Development indicators | Log fixed capital formation as divided by GDP |
| High-tech value added | UNIDO and World Bank Development indicators | Log of value added coming from the sectors with sic code 28, 35, 36 and 38 divided by GDP |
| Δ High-tech value added | UNIDO and World Bank Development indicators | Average annual log growth in High-tech value added to GDP from t+1 to t+5 |
| New high-tech establishments | UNIDO and World Bank Development indicators | Log of new establishments scaled by population coming from the sectors with sic code 28, 35, 36 and 38 |

| Variable | Source | Description |
|---|---|---|
| ICT value added | UNIDO and World Bank Development indicators | Log of value added coming from the sectors with sic code 35, 36 and 38 divided by GDP |
| Granted high-tech patents | UNIDO and World Bank Development indicators | Log of granted ICT and biotech patents at the USPTO (at the publication date) divided by population |
| Value traded | World Bank Financial Structure Database | Log of value of stock market transactions divided by GDP. |
| Turnover | World Bank Financial Structure Database | The ratio of equity market value traded to the market capitalization |
| Market capitalization | World Bank Financial Structure Database | Log of the value of listed shares on a country's stock exchanges divided by GDP. |
| Bank credit | World Bank Financial Structure Database | Log of deposit money bank credit to the private sector divided by GDP. |
| Industry value added | UNIDO and World Bank Development indicators | Log industry value added to GDP |
| ΔIndustry value added | UNIDO and World Bank Development indicators | Average annual log growth in industry value added to GDP from t+1 to t+5 |
| HT | UNIDO database and authors' own calculations | Indicator variable taking on the value 1 if the industry's sic code is 28, 35, 36 and 38 and zero otherwise |
| ICT | UNIDO database and authors' own calculations | Indicator variable taking on the value 1 if the industry's sic code is 35, 36 and 38 and zero otherwise |
| ΔTFP | UNIDO database and authors' own calculations | The residual from regressing log(capital formation) and Δlog(employment) on Δlog(value added). |
| ΔCap | UNIDO database and authors' own calculations | Log(capital formation). |
| ΔNr of firms | UNIDO database and authors' own calculations | Average annual log growth in number of establishments from t+1 to t+5. |
| ΔSize of firms | UNIDO database and authors' own calculation | Average annual log growth in employment divided by number of establishments t+1 to t+5. |

## Table A.II

## Country characteristics

| Country | GDP per capita growth | TFP growth | Capital stock per capita growth | Value traded | Bank credit | High tech value added |
|---|---|---|---|---|---|---|
| Argentina | -0.014 | -0.012 | 0.010 | 0.020 | 0.190 | 0.006 |
| Australia | 0.022 | 0.011 | 0.015 | 0.328 | 0.588 | 0.011 |
| Austria | 0.018 | 0.012 | 0.027 | 0.050 | 0.874 | 0.015 |
| Belgium | 0.020 | 0.011 | 0.021 | 0.089 | 0.500 | 0.032 |
| Brazil | 0.007 | 0.009 | 0.018 | 0.106 | 0.334 | 0.013 |
| Canada | 0.017 | 0.005 | 0.029 | 0.291 | 0.946 | 0.021 |
| Chile | 0.031 | 0.018 | 0.028 | 0.057 | 0.562 | 0.019 |
| Denmark | 0.019 | 0.011 | 0.016 | 0.185 | 0.581 | 0.022 |
| Finland | 0.022 | 0.015 | 0.020 | 0.403 | 0.624 | 0.018 |
| France | 0.015 | 0.010 | 0.024 | 0.270 | 0.814 | 0.022 |
| Germany | 0.010 | - | - | 0.390 | 1.073 | 0.015 |
| Great Britain | 0.022 | 0.012 | 0.023 | 0.622 | 0.951 | 0.060 |
| Greece | 0.008 | 0.005 | 0.008 | 0.051 | 0.378 | 0.004 |
| Hong Kong | 0.038 | 0.026 | 0.053 | 0.926 | 1.471 | 0.006 |
| India | 0.034 | 0.022 | 0.035 | 0.228 | 0.249 | 0.010 |
| Indonesia | 0.039 | 0.014 | 0.076 | 0.048 | 0.282 | 0.006 |
| Ireland | 0.039 | 0.028 | 0.046 | 0.260 | 0.761 | 0.082 |
| Israel | 0.016 | 0.007 | 0.012 | 0.200 | 0.599 | 0.025 |
| Italy | 0.017 | 0.014 | 0.022 | 0.189 | 0.589 | 0.033 |
| Japan | 0.018 | 0.012 | 0.041 | 0.428 | 1.515 | 0.108 |
| Korea | 0.051 | 0.025 | 0.075 | 0.596 | 0.975 | 0.100 |
| Malaysia | 0.045 | 0.021 | 0.061 | 0.520 | 0.961 | 0.088 |
| Mexico | 0.009 | -0.004 | 0.006 | 0.079 | 0.178 | 0.013 |
| Netherlands | 0.017 | 0.011 | 0.016 | 0.602 | 1.164 | 0.048 |
| New Zealand | 0.018 | -0.001 | 0.009 | 0.116 | 0.769 | 0.007 |
| Norway | 0.026 | 0.016 | 0.022 | 0.173 | 0.888 | 0.028 |
| Pakistan | 0.032 | 0.026 | 0.026 | 0.032 | 0.231 | 0.009 |
| Peru | -0.005 | -0.018 | -0.007 | 0.018 | 0.143 | 0.008 |
| Philippines | 0.002 | -0.002 | 0.017 | 0.086 | 0.337 | 0.027 |
| Portugal | 0.024 | 0.015 | 0.042 | 0.106 | 0.845 | 0.020 |
| Singapore | 0.044 | 0.025 | 0.046 | 0.582 | 1.057 | 0.182 |
| South Africa | 0.008 | 0.001 | -0.014 | 0.256 | 0.903 | 0.016 |
| Spain | 0.027 | 0.009 | 0.024 | 0.487 | 0.808 | 0.032 |
| Sweden | 0.018 | 0.007 | 0.013 | 0.472 | 0.992 | 0.062 |
| Switzerland | 0.007 | -0.001 | 0.006 | 1.426 | 1.549 | 0.095 |
| Trinidad | 0.016 | 0.004 | 0.022 | 0.018 | 0.458 | 0.025 |
| Thailand | 0.088 | 0.048 | 0.076 | 0.242 | 0.888 | 0.044 |
| Turkey | 0.020 | 0.004 | 0.034 | 0.180 | 0.147 | 0.004 |

# Table A.III

## Sample descriptive statistics

| Variable | Mean | 25th | Median | 75th | Std. Dev. |
|---|---|---|---|---|---|
| GDP per capita growth | 0.023 | 0.010 | 0.022 | 0.034 | 0.023 |
| TFP growth | 0.011 | 0.001 | 0.010 | 0.022 | 0.017 |
| Capital stock growth | 0.026 | 0.011 | 0.023 | 0.040 | 0.026 |
| ΔHigh-tech value added | 0.075 | -0.014 | 0.028 | 0.078 | 0.235 |
| ΔIndustry value added | 0.056 | -0.040 | 0.006 | 0.071 | 0.259 |
| HT | 0.261 | 0 | 0 | 1 | 0.439 |